

NSWC Carderock Hosts Competition to Develop Wave Energy Converters

AquaHarmonics Wins the Energy Department's Wave Energy Prize

THE U.S. DEPARTMENT of Energy's (DOE) Office of Energy Efficiency and Renewable Energy announced AquaHarmonics as the winner of the 2016 Wave Energy Prize competition—which comes with a \$1.5 million grand prize. The finalist teams tested their prototype devices at the nation's most advanced wave-making facility—the Maneuvering and Seakeeping (MASK) basin at the Naval Surface Warfare Center (NSWC) Carderock Division in West Bethesda, Maryland. CalWave Power Technologies and Waveswing America were awarded second and third place, respectively, with \$500,000 and \$250,000 in cash prizes.

judges ultimately identified nine finalists and two alternates, which were announced in March 2016. These teams received up to \$125,000 in seed funding to build scaled prototypes of their wave energy converter devices.

On November 16, 2016, the nine finalists displayed their innovations at Carderock during the Wave Energy Prize Innovation Showcase. The event was attended by such distinguished guests as the DOE Under Secretary for Science and Energy, Dr. Franklin (Lynn) Orr; Assistant Secretary of the Navy (Energy, Installations & Environment), retired Vice Admiral Dennis McGinn, Deputy

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A 20-month design-build-test competition, the Wave Energy Prize focuses on catalyzing the development of game-changing wave energy converters that will ultimately reduce the cost of wave energy. Wave energy is produced by converting the energy from waves into electricity.

With more than 50 percent of the U.S. population living within 50 miles of coastlines, there is vast potential to harness wave energy to provide clean, renewable electricity to communities, businesses, and cities across the United States.

Ninety-two teams registered for the prize beginning in April 2015. Over the course of the competition, a panel of

Assistant Secretary of the Navy for Energy, Joseph Bryan; and Founder, Chairman, and Chief Technical Officer of Masten Space Systems, David Masten.

“The Wave Energy Prize marks a significant advance for marine energy,” said Orr. “This competition set a difficult threshold of doubling the energy captured from ocean waves, and four teams surpassed that goal.” The winning team's technology, in fact, actually quintupled the captured energy.

Alex Hagmuller and Max Levites-Ginsburg of team AquaHarmonics, both civilian engineers and graduates of Oregon State University, took the top prize with their wave

energy converter (WEC) concept and model of a point absorber with latching/de-clutching control. Levites-Ginsburg described their device as a buoy with a generator inside, anchored to the sea floor. Any relative motion from the point on the sea floor to the elevation of the device caused the generator to spin and produce electricity.

“Early on, we were working out of a garage and we didn’t have a lot of resources or great facilities,” Levites-Ginsburg said. “We tried to make the best of what we had, but we didn’t really have a lot. It was really surprising what we were able to achieve.” He added that they had been working on their project in some form for the last five years.

“The Wave Energy Prize laid out some goals for us to achieve that really pushed us in directions that maybe we wouldn’t have pursued on our own,” Levites-Ginsburg continued, “but ultimately led us down a path to enable us to make the right discoveries ... and make the right design choices.”

“AquaHarmonics’ leap incentivized by the Energy Department demonstrates how rapid innovation can be achieved in a public prize challenge,” Orr stated.

“It says so much about America, about America’s innovation, [and] our inventors that this small team literally operating out of a garage in Portland, Oregon, [has] won this \$1.5

million Wave Energy Prize,” said McGinn. “For them, this is just the beginning. It’s a wonderful milestone, and they will be moving forward to continue to refine and scale up this type of technology.”

In the number two slot was CalWave Power Technologies, a team from Berkeley, California, who designed a submerged pressure differential device. Waveswing America, a company with 40 years of experience in wave energy research took third place with their sub-sea pressure-differential point-absorber.

A Long-term Cooperative Effort

The victory doesn’t belong to the winning teams alone; it’s also the culmination of years of work on the part of the many members of government and private industry involved in the Wave Energy Prize contest. Jim Ahlgrimm, director of DOE’s Water Power Technologies Office, spoke at the beginning of the awards ceremony about DOE’s vision for the contest and the critical support of Carderock and other partners in the

contest. During the final phase of the competition, Carderock provided assistance in the form of signal conditioning, data acquisition, general logistics, mooring, and optical tracking. Carderock personnel also served as test directors.

Dave Newborn, an ocean engineer with Carderock’s Maritime Systems Hydromechanics Branch, and Miguel Quintero, an ocean engineer with the Full-Scale Trials Branch, have been involved throughout the entire process. Their involvement included writing the competition rules, serving as judges and test directors, and providing technical and logistical support for contestants and program-identified partners like the Sandia National Laboratory in Albuquerque, New Mexico, and the National Renewable Energy Laboratory in Golden, Colorado.

Previous stages in the Wave Energy Prize involved competitors designing different archetypes for WEC devices, such as point absorbers, line absorbers and terminators. Then, contestants built and tested proto-



Alex Hagmuller, one of the co-winners of the 2016 Wave Energy Prize competition from AquaHarmonics, tells the crowd at NSWC Carderock how their WEC is working to absorb energy from waves, which can then be converted and used as a power source.

Monica McCoy



Aqua Harmonic's wave powered single point generator is demonstrated during an innovation showcase in the MASK basin at NSWC Carderock Division in West Bethesda, Maryland.

Petty Officer 2nd Class Heath Zeigler

The Basics About Carderock

NSWC CARDEROCK DIVISION, a part of the Naval Sea Systems Command, leads the Navy in hull, mechanical and electrical engineering. Headquartered in West Bethesda, Maryland, the Carderock Division employs approximately 2,000 scientists, engineers, technicians and support personnel and includes detachments in:

- Bangor, Washington
- Bayview, Idaho
- Fort Lauderdale, Florida
- Ketchikan, Alaska
- Memphis, Tennessee
- Norfolk, Virginia (Little Creek)
- Port Canaveral, Florida

types built to 1/50 scale. Subsequent to this stage, the original 68 competitors were narrowed to the nine finalists, who began conducting tests on 1/20-scale prototypes in the MASK basin.

"The reason the testing has moved here at this stage is that no one has a facility this large that can generate waves of this size to get the appropriate scale for the devices," Newborn said. "The DOE came to us because of the big tank, the big waves we can make, and the expertise we have here. There's a lot of money at stake here. With a vital program like this one, the data has to be as thorough and accurate as possible."

The Wave Pool

The MASK basin, where the final competition took place, is the Navy's largest wave pool. It's 360-foot long, 240-foot wide, and holds approximately 12 million gallons of water. It's used to evaluate the maneuverability, stability and control of ships, platforms and moored systems in realistic sea conditions.

For More Info

FOR MORE INFORMATION about the work taking place at this facility, see our article in the winter 2015-16 issue of *Currents*, “NSETTI Program’s Energy Innovation Demonstration Projects Showing Promise,” by visiting http://greenfleet.dodlive.mil/files/2016/02/Win15-16_NSETTI_Energy_Demo.pdf.

“It’s about what it costs to get the power; not just getting renewable energy, but doing it at a cost that makes sense,” Newborn said.

“If you look around, it doesn’t take long to go to the beach and see, ‘Wow, that’s a lot of energy,’” said McGinn. “So figuring out how we can harvest that energy in an inexpensive, reliable way makes so much sense. It will add to our energy portfolio...along with wind and solar.”



The wave energy sector is in its early stages of development, and the diversity of technologies makes it difficult to evaluate the most technically and economically viable solutions. The Wave Energy Prize competition addressed this challenge by comparing a wide range of device types and evaluating them against a threshold requirement for high energy capture.

Go to water.energy.gov for information on funding opportunities through the Water Power Technologies Office. This office sponsors the development of innovative technologies that generate renewable, environmentally friendly, and cost-competitive electricity from water resources.

Built in 1962, the basin recently underwent a six-year upgrade to replace the original pneumatic wave making system with 216 individually controlled electromechanical wave boards that significantly enhance the capability to create a precise wave environment and simulate the ocean’s most extreme conditions.

Hosting the competition at the basin provided additional benefits to the command. An underwater optical tracking system, developed for use in the tests, provides the ability to track motions for submerged or surface-piercing bodies. This system is being tuned and modified for use at Carderock, with the goal of establishing a flexible, reconfigurable motion-capture system that could track bodies in the entire basin and sections of the other basins around base.

The MASK basin isn’t the only Department of Navy facility involved in developing and testing WEC technologies. The Wave Energy Test Site, in the waters off Marine Corps Base Hawaii, has been working in the field since 2003. Two additional testing berths were installed in 2014 as interest in the environmental feasibility of wave energy generation begins to build.

The goal of the Wave Energy Prize is to determine which archetype device is best to move forward with.



To see the full results of the competition or for more information about the Wave Energy Prize, go to waveenergyprize.org. [↗](#)

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